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ABSTRACT

This paper describes the role of the school-based mathematics specialist of the Project IMPACT (Increasing the Mathematical Power or All Children and Teachers) whose primary purpose is to design, implement, and evaluate a model for primary mathematics instruction that will enhance student understanding and support teacher change in predominantly minority schools. The program is described followed by a description of the selection and role of the mathematics specialist. The supportive interaction among specialists and with classroom teachers is discussed, including excerpts from specialists' journal writings to indicate both the nature of and the need for specialist-teacher interactions. Concluding the paper is a list of recommendations for encouraging teacher change. (MKR)

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School-based Mathematics Specialists: Providing On-site Support for Instructional Reform in Urban Mathematics Classrooms

The Project IMPACT Model

by
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School-based Mathematics Specialists: Providing On-site Support for Instructional Reform in Urban Mathematics Classrooms

The Project IMPACT Model

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School-based Mathematics Specialists: Providing On-site Support for Instructional Reform in Urban Mathematics Classrooms

The Project IMPACT Model

Project IMPACT (Increasing the Mathematical Power of All Children and Teachers) was first funded by the National Science Foundation in December, 1989. Its primary purpose is: To design, implement, and evaluate a model for primary mathematics instruction that will enhance student understanding and support teacher change in predominantly minority schools.

The schools participating in the project are located just outside Washington, D.C. in suburban Maryland. The neighborhoods from which the schools draw their students are urban in character, with the majority of the children coming from apartment complexes. At the time of initial implementation in 1990, the schools had minority populations ranging from 54% to 90%. Many of the children who attend these schools do not speak English as their native language. The percentage of non-English speakers is as high as 65% in one of the schools. While Spanish is the language spoken by most of those who do not have English as their native language, there are also many speakers of various Asian dialects, African dialects, and some Mideastern dialects.

The project is a school-based in-service program, as opposed to a teacher-based program. That is to say, it was designed and organized to provide professional development to all of the mathematics teachers at a given grade level each year. This means that the teachers who participated were not volunteers. It does not mean that many

of them would not have volunteered under different circumstances. It simply means that that was not an option in our project and that some of the teachers came only because it was required. During the first year the in-service was designed to support kindergarten and first grade teachers. The second year in-service was aimed at second-grade teachers. The third year focused on third grade, followed by fourth grade in the fourth year and fifth grade in the fifth year. The summer in-service program included the following components: a)prior research on children's learning of mathematics; b)equity in classrooms with diversity; c)mathematics content instruction for all the teachers; d) experience in implementing this instructional approach with summer school children; and e) sample instructional materials.

Each implementing school is provided with a school-based mathematics specialist to support teachers and to give follow-up in-service during the school year. Principals were asked to provide a time during the school day that teachers could meet for at least one hour each week to discuss problems with each other and the specialist and to revisit the instructional emphases of the summer in-service program. In reality, as the project continued and expanded, this request was not fully achieved in all of the participating schools. Some schools have extended planning every two weeks or once a month. One school schedules its grade level planning after school hours. Each school was also supplied with the manipulative materials that were felt to be necessary for the implementation of the instructional vision of the NCTM Standards (NCTM, 1989 and 1991) and the goals of the project.

The project's instructional approach focused on the children's development of conceptual understandings and self confidence (mathematical power) in order to establish a foundation for success in higher level mathematics as well as the capacity to successfully solve real mathematical problems that the children would face inside and outside of school. The theoretical perspective supports a cognitive constructivist theory of learning. Initially teachers are asked to pose problems and to observe how their students solve the problems. For many teachers this is a huge pedagogical shift, particularly if their mathematical instructional approach has been to present problems, to show students how to solve them, and then to evaluate their effectiveness by whether the students obtain the correct answers and successfully mimic the procedure that was taught. The problems that teachers face when attempting this new instructional approach are very different from those they face when using such a traditional, direct instruction approach (Simon, 1995; Stein, 1995.) For many teachers it is difficult to learn to look at children's work and to listen effectively to the children's explanations. Teachers must learn how to interpret children's responses to gain the information that the teachers need to develop or modify instructional plans and to define questioning strategies to foster or challenge the understanding that is being demonstrated by individual children. We ask the teachers to do this in order to plan effectively for students. Planning based upon observed student performance also demands of teachers a research perspective with respect to children's learning of mathematics. The focus on student work and explanations in order to evaluate student understanding can lead to advancing the student to new or more mature understanding of content or to providing instruction that will move students to develop

more efficient strategies within the current content level. One of the important functions the mathematics specialist has in these schools is to support and foster these behaviors in the teachers.

Selection and Role of the School-based Mathematics Specialist

It was our belief as this project was developed that a specialist was essential to fostering the desired teacher changes. As was mentioned earlier, these kinds of changes are not easy ones for teachers to make. "The role of the mathematics teacher [using constructivist strategies] is a very demanding one." (Simon, 1995, p.142) The teacher who has previously used traditional approaches must make significant changes. These changes are likely to be accomplished only if adequate support is available. When considering what makes change work for teachers, Fullan argues that, "Teacher isolation and its opposite---collegiality---provide the best starting point for considering what works for the teacher." (1991, p. 131). The issue of whether the teachers have the time to share with and support each other is thus a critical one. The mathematics specialist and the requested planning time of Project IMPACT were aimed at fostering collegiality and the sharing of common understandings and problem solutions. The need for this time to develop collegiality has also been expressed by Stein (1995.)

The school-based mathematics specialists were, with one exception, classroom teachers from the school district who were released from classroom instruction to assume these new responsibilities. The specialist who is the exception was a fourth grade teacher in a private school. She has a doctoral degree in elementary mathematics education and was selected to serve as the team leader for the specialists. The specialists who were hired

from the school system classrooms were selected by the district's normal procedure of advertising the vacancy to all interested applicants who met the requirements of the job description. These requirements included: 15 credits of mathematics, at least three years of successful classroom teaching, prior experience working with adults, excellent evaluations for observed classroom teaching, and some indication of understanding the constructivist perspective with respect to teaching children. In some cases a preference was given to candidates who could speak Spanish.

Once the specialists were selected, they were expected to begin exercising their leadership roles as soon as possible. During the first year of the project, and in all subsequent years, the specialists were asked to take on the role of leaders beginning with the summer workshop. This meant helping to teach the summer workshop and, in subsequent years, helping to plan the summer workshop. Each newly hired specialist was expected to provide a portion of the instruction in the summer workshop after having some time to observe and then to collaborate with the project directors and other specialists in this leadership role. An important component of the specialist's role in the summer workshop was to work with the teachers from her school to plan instructional activities for at least the first month of school. Further, in the summer, each school's grade level team planned its' mathematics content goals for each nine-week grading period. This helped to minimize the frustration of trying to implement new instructional strategies during that first critical month of teaching.

During the school year the specialists provide a variety of support activities for teachers. These include the following: demonstration teaching and follow-up; co-

teaching and follow-up, observation of teaching and follow-up, releasing teachers to see other teachers, leading the weekly grade-level planning meetings, helping to plan instructional activities; helping to design and make instructional materials that were not purchased; identifying, ordering and managing instructional materials; and being available to help teachers find answers to questions that might otherwise interfere with continued efforts to implement the advocated instructional approach. Activities that occur early in the school year differ from those that occur later in the year. At the outset there is more demonstration teaching. As the year progresses, this changes to co-teaching. Late in the school year, most of the time is spent observing and giving feedback, with demonstration or co-teaching occurring only when there is a special need of some sort. Changes that occur in the planning sessions are also indicative of the demanding role for teachers and specialists. Early in the year the planning sessions focus on survival. Lessons are planned in some detail. When the planning has become more comfortable, then the focus shifts to developing good questions and giving wait time for children to think before they respond. The next refinement of planning is to observe individual student work and to take a less superficial look at student strengths and weaknesses in order to make instructional decisions that provide equal access to the mathematics for all students, while allowing for differentiation when that is appropriate to meet student needs. A further refinement of this has teachers consider ways to embed assessments in their instructional activities. The intention is to help teachers to see and interpret levels of student understanding so that the teachers can make still better instructional plans. This really require that the teachers

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become more cognizant of the related research addressing student learning of mathematics.

In addition to supporting the teachers who participated in the summer in-service workshops, the specialists are called on to communicate the purposes and methods of the project to many other audiences. These include new teachers who were hired after their grade-level in-service workshop, parents, instructional assistants, and visitors from outside the school. The issue of newly hired teachers is significant in these schools. Schools that are experiencing the kind of social stress that the project schools face have a rate of teacher mobility that is often higher than their student mobility. At some grade levels in some of our project schools, all of the teachers who participated in the original workshops have now transferred to other, less stressful, schools in the district. The need for the specialists to be available to provide guidance to newly hired teachers is critical.

It is also important for the school principals to understand the project so that they can support its implementation. At the same time, at least in our project, it was not possible to get an extended period of time with the principals that would allow for a complete in-service workshop. Their schedules were simply too full. A brief workshop was provided, with follow-up meetings during the school year to clarify the project and to answer questions. This was critical, since the principals are responsible for observing and evaluating the teachers. The specialists were also in the buildings to answer the principals' questions as they arose. Despite this, there were still occasions when teachers felt they were being evaluated negatively while doing what was asked of them by the project.

Supportive Interactions Among Specialists

Like the teachers, specialists hired from classroom teaching positions need support to develop the background knowledge necessary to implement the goals of the project in their diverse school settings. Weekly meetings led by the specialist team leader and supported by one or both of the project directors are scheduled. At these meetings the specialists discuss issues such as: ways to encourage teachers to focus on student strategies; ideas for teaching topics that are particularly difficult; methods of encouraging teachers who are having particular difficulties with the constructivist approach of the project; ways of meeting the diverse needs of the students in the classrooms of project schools; ways that teachers can differentiate instruction in the diverse classrooms; and plans for parent meetings to explain the project.

Specialists occasionally take over a teacher's classroom so that the released teacher can visit the classroom of another teacher. If the classroom to be visited is in a different Project IMPACT school, then the specialists of the schools involved work together to assure a beneficial experience for the visiting teacher. These visits always have a focus. For example, one teacher might visit another classroom to observe ways of getting students to record what they are doing with mathematics symbols. Specialists also work together to plan and coordinate visits from outside the school system. In several of the schools, specialists have conducted after school mathematics "clubs" for children who have special mathematics needs. While classroom teachers could run such clubs, they usually do not because they are so busy keeping up with the many demands of their regular duties and the changes they have been asked to make. One exception to this has

been the offering of "Family Math" programs. Each semester a classroom teacher and the Project IMPACT specialist work together to engage parents and children in activities that promote the construction of mathematical knowledge. The teacher and specialist use these programs, as well as locally organized family math nights, as vehicles to make parents aware of the NCTM Standards (NCTM, 1989 and 1991) and, at the same time, to educate and to provide the parents with practical mathematics activities that they can do with their children.

Specialist Interactions With Classroom Teachers

Elementary school classroom teachers vary with respect to their mathematics backgrounds. Many of them do not have strong backgrounds in mathematics nor are they aware of the research underlying the learning of mathematics (Simon, 1995.) The school-based mathematics specialist is able to assist the teachers as they work to build the mathematical backgrounds to evaluate student responses and to make instructional decisions that will foster growth in mathematical understanding. In our project, the need for this type of support has not decreased as we moved up in grade level. One might have speculated that teachers in the upper grade levels would have stronger mathematics backgrounds, possibly because such stronger backgrounds prompted them to choose to teach in the upper grades, or because teaching upper grade mathematics would build a stronger mathematics background, even if that did not exist prior to entering into upper grade teaching. To some extent, we found this to be the case in our project schools. However, this increase in mathematics content knowledge did not, in general, result in less

difficulties implementing the instructional approaches of the project. To some extent, there is an increase of difficulty, in spite of the stronger mathematics background. The reason for this phenomenon may be the increased complexity of the mathematics curriculum in the upper elementary grades and the increased difficulty of applying constructivist strategies to the treatment of that curriculum. It could also be the greater internalization of traditional directed instructional approaches in the upper elementary grade levels where the plethora of traditional procedures for "getting an answer" are so great. As the mathematics curriculum becomes more symbolic and procedural, it is much more tempting to simply "drill the rules."

Efficient procedures for multi-digit multiplication and division, for example, are among the most complex procedures that students are ever asked to create or learn in mathematics. Asking questions that will assist students in developing efficient procedures for these operations and recognizing correct efficient procedures when they are invented by students is very challenging. Our specialists and classroom teachers have worked very hard to deal with this issue. It is our feeling that many of the teachers in all grade levels, but particularly in the upper grade levels, would not have persisted in this effort without the support of the specialist and their colleagues. This point has been made by other writers (Knapp and Peterson, 1995; Noddings, 1992.) Some project teachers have not persisted even with the support of the specialist. The need for all teachers to be supported in continuing implementation is a particularly important issue in a school-based effort where the teachers are not volunteers.

Classroom teachers in our schools have also been burdened by standardized testing, assessment, and accountability requirements that put pressure on them to cover the curriculum at a pace that is not very compatible with allowing students to construct real understanding. Again, this problem becomes more severe in the upper grade levels. The criterion referenced assessment system, in particular, required that students not only be able to produce correct answers efficiently at a particular time if they were to be considered "on grade level," it also required that those students use a particular algorithm. This pressure from the tests and ongoing assessment system was compounded for fifth-grade teachers who had to prepare students for performance in middle school, where there was reason to doubt that future teaching would be consistent with the ideas of Project IMPACT. This latter issue indicates the need for efforts not only to provide a consistent approach to mathematics instruction within a school, but also to provide for consistency between schools that serve the same children.

The following are excerpts taken from specialists' journals that indicate both the nature of and the need for specialist-teacher interactions. While positive interactions do occur on a regular basis with some of the teachers, there is nothing to indicate that these teachers would be doing these things if the specialist were not available. All names in the excerpts have been changed. All of the excerpts are taken from the 1994-95 school year, which causes most of them to be drawn from fourth- or fifth-grade implementation. Similar experiences occurred in previous years.

For these notes to be understood, it is necessary to explain something about the mathematics program in this school system. As briefly mentioned above, the system has developed a computerized assessment/management system (known as ISM) that teachers are required to use. Each school has a full-time or part-time instructional assistant whose role is to assess students and to maintain the student records in a computer. The number of curriculum "levels" that are recommended to be taught each year ranges from 16 in kindergarten to 33 in grade 5. A level is usually made up of several related objectives. A report is generated each quarter of the school year which indicates the average number of levels passed by the children in each class.

(Fourth grade teacher) He wanted (the students) to figure out a rule for finding the area of an octagon. I asked if he was doing this for him or the kids. I wish he'd focus on basic facts or something more realistic. Talk about challenges? He wants these children to be amazed at his brilliance!

(Fourth grade) I am assuming that they have [all] probably taught the standard algorithm [in the past.] All [teachers] said that if a kid does something that takes longer, it is not efficient.

(Fifth grade) Bob is feeling very positive still. The teachers feel that our planning meetings have been extremely important. Although they're time consuming, they really feel they are learning a lot as we talk about how lessons went---what they might have done differently or what went very well.

(grade not important) (The principal) is requiring that the ISM assistant be present in all 5th grade classes when paper/pencil tests are being administered. (The principal's)

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attitude that 6-7 ISM levels must be covered during this quarter has resulted in a lot of stress on Gina and Louise.

(Fifth grade) Sally asked me to take all the ISM objectives for units 3 & 4 and develop instructional lessons based on those objectives. I tried to tactfully let her know that this was her job and that she was the best person suited to make those decisions since she knows her students academically.

(Fourth grade) Eddie has his students sitting in rows because according to him, "sitting in groups makes the students feel like I'm stereotyping them."

(Fifth grade) ... many of the students were using repeated addition. The children were either taking too long to solve the problems and/or were making computational errors. ... We decided to have the children who were doing repeated addition work with manipulatives and have them record symbolically what they were doing. We modeled this type of recording for them because we wanted them to focus on recording with numbers and not words. The results were good.

(Fifth grade) Dan said that he doubts that he would have tried to change. It's easier to do what you've always done.

(Fifth grade) ...they [the teachers] like it when I do parts of a lesson from time to time because they can "gauge" themselves.

(Fifth grade) Teachers like having an extra set of eyes in the room because I can give them feedback on how I see the kids responding to lessons.

(general) What's going to be very challenging for her [the principal] next year is filling the spots for the teachers who are strongly considering leaving. [The principal] doesn't know yet, but Jim, Barbara, Beth, and Katherine are considering leaving.

(Fifth grade) I worry for her kids. She's got some very capable students that I think are turning off. Ed's kids are getting a completely different experience. It makes me sad that one group seems to be getting so much more than the other.

(Fifth grade) ... Ed and Sara complain about how poorly the kids compute... and how meaningless it is to go on with problem solving using larger numbers, when it takes most of the kids forever to come up with an answer...

(Fifth grade) On Monday he was talking about compatible numbers and in the middle he began talking about decimal equivalents with fractions. Then the next day when he began a new strategy (for adding certain numbers) he got off on a tangent about exponents, square roots, powers and multiplication.... I don't have a clue why he was working on this.

(Third grade) We observed Ms. W's class. She had an absolutely brilliant lesson. Perfect for observing.

These excerpts indicate the kinds of problems that both the teachers and the Project IMPACT specialists wrestle with as they work together (at least in most cases) to implement this approach to instruction. They also give some indication of the powerful effect that outside assessment has on teacher comfort with making changes that do not focus on getting right answers.

Concluding Remarks and Recommendations

Each school system has its unique characteristics that affect the performance of classroom teachers. Specialists who are selected from among the classroom teachers will know these characteristics and will therefore be in a better position to assist other teachers in dealing with them. The more recent the classroom experience of the specialist, the more likely it is that the other classroom teachers will accept the specialist as "having her feet on the ground." Those who are far removed, in terms of time, from classroom experience are often viewed as not knowing what the "real world" is like. Having come from the classroom recently also makes a specialist more acceptable as an observer/reactor. They are more likely to be sympathetic to the realities that may dictate certain types of classroom decisions.

During the implementation of Project IMPACT two primary schools were phased out of supporting services from specialists as the children in the study moved into the upper-grade elementary schools. The principals and teachers of those schools expressed great concern over the loss of the mathematics specialists. In one school, the principal used short-term local funds to create a position and to hire a teacher who had participated in a Project IMPACT workshop as her mathematics specialist. The other school used substitute funds to release teachers monthly to continue their grade level planning meetings and asked the specialist who had moved on to the upper grade school to help run these meetings. These actions indicate the value that the principals and staffs placed on the contributions of the mathematics specialist.

How would the implementation of a project of this type be affected if the teachers were volunteers rather then being required to attend? It would be a classroom-based, rather than a school-based project. However, the volunteers might have a level of commitment that would reduce the need for specialist support. This would lower the cost of implementation. Volunteer teachers might also achieve results that were more easily measured and used to convince other teachers and the community at large of the merits of this instructional approach. They would very likely be excellent spokespersons for enlisting other teachers to volunteer and participate. However, there would be no way to assure that the reluctant teachers would ever volunteer. All of the students who would benefit from this type of instruction would not receive it. Teachers also would not have the full benefit of working together as a team. In the case of schools experiencing the severe social stress that our project schools are under, we believe that a volunteer approach would not be in the best interest of the students or the teachers. If the teachers did not feel that there was a common instructional goal that they were all being asked to work toward, it could create unnecessary tensions. The high mobility rate among the teaching staff is already a problem that makes it difficult to maintain a consistent team effort. In fact, the instructional assistants, who have less flexibility with respect to moving to new schools, tend to stay longer than the teachers. In the process, they become the senior personnel in the building.

Recommendations

- School systems which expect teachers to make changes, especially changes of the magnitude described in the NCTM Standards documents, must treat teachers as

professionals and give them adequate time to grow professionally and to plan their instruction so that it will meet the needs of their students. Time must be provided for teachers to continue to reflect on their practices after the initial in-service workshop is over. This reflection time should be organized so that teachers can work together to confront common problems and curricular issues.

- A school-based approach should be used whenever possible to accelerate the pace of change and to encourage within-school cooperation and cohesiveness.
- In-service programs should not just be a collection of activities that can be done, even if they are good activities. They must be organized to require teachers to reflect on their current practices and to contrast them with appropriate practices as indicated by the research literature. Some good activities may be included to model the practices that the teachers are being asked to use, but they should be clearly connected to the research on children's learning of mathematics.
- Schools that are experiencing severe social and economic stress require additional assistance, such as that of an in-school mathematics specialist, to initiate and to maintain changes in instructional practices.
- Change cannot be institutionalized within a school if the staff changes drastically within a relatively short period of time. Incentives should be provided to encourage teachers to stay in the school once they have received the in-service and successfully begun to implement the changes.
- School systems that wish to implement instructional approaches that reflect current research on student learning should change their assessment systems to avoid putting

teachers into conflicting demands that make it extremely difficult to implement the new programs. In our case, assessment requirements were not modified, at least partially because of school system policies against easily modifying them for research projects. Such policies should be modified for profects such as this, where previously investigated successful instructional approaches are being utilized in new settings. Although we obtained significant achievement gains, we do not feel that we reached the real potential that this instructional approach has to offer. (The Montgomery County Schools are currently in the process of modifying some parts of the assessment system to include open ended and performance assessments items.)

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